THE FOLLOWING ARE THE ENGLISH TRANSLATION OF ANNEXES TO THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT (ARTICLE 34):

Amended Sheets (Pages 3-6, 6a, and 17-24)

2002/0060995, upon request of the AP, a terminal measures the signal strength and the bit error rate on a multiplicity of channels with nearby access points, and transmits the measuring results to the requesting access point. According to US 2002/0060995, the access point selects, if necessary, a new radio frequency channel on the basis of the received measuring results. The method according to US 2002/0060995 has the drawback that both the computerized access points and the terminals must be provided with supplementary software modules. According to US 2002/0060995, the computerized access point moreover has to announce the change to a new radio frequency channel by means of special messages to all terminals. Both resources of the access point as well as resources of the terminals must be used for the quality measurement and for the change of channel.

Described in the patent application GB 2308789 is a method and apparatus for management of frequency spectra in cellular radio communications networks. According to GB 2308789, data about the use of frequency by base stations of the radio communications network and about operational values of the base stations are captured and stored in a central unit. Based on the stored data, the central unit determines alternative frequency spectra for the base stations and transmits corresponding instructions to the respective base stations.

Disclosure of Invention

It is an object of the present invention to propose a new computer-based system for dynamic assignment of carrier frequencies to computerized access points of a wireless local area network and a computer program product for control of one or more processors of such a computer-based system, which do not have the drawbacks of the state of the art. In particular, it is an object of the present invention to propose a new computer-based system and a computer program product suitable therefor which enable the dynamic assignment of carrier frequencies to computerized access points of a wireless

local area network without software or hardware changes having to be made at the computerized access points of the wireless local area network for this purpose.

These objects are achieved according to the invention in particular throught the elements of the independent claims. Further advantageous embodiments follow moreover from the dependent claims and from the specification.

The above-mentioned objects are achieved by the present invention in particular in that a computer-based system is provided for dynamic assignment of carrier frequencies to the computerized access points of a wireless local area network, which computer-based system is connectible to the computerized access points via a communication connection. According to the invention, the computer-based system is set up to store access point data about the computerized access points, the access point data comprising in each case at least the present carrier frequency of the respective computerized access point. Finally, the computer-based system is set up to determine an optimal carrier frequency for a first of the computerized access points, based on the stored access point data about the computerized access points, and to set the determined optimal carrier frequency at the first computerized access point via the communication connection. By storing the access point data in the computer-based system and by determining the optimal carrier frequencies for the computerized access points in the computer-based system based on the stored access point data, individual, optimized carrier frequencies can be determined for the access points taking into consideration access point data of neighboring access points. This means that, in determining the optimal carrier frequency for a respective access point, not only data about the respective access point, but also data about all access points in the vicinity of the respective access point are also taken into consideration. By determining optimal carrier frequencies in the computer-based system and by setting the determined optimal carrier frequencies in the access points via the

communication connection, optimal carrier frequencies can be assigned to the access points without special steps having to be taken for this purpose in the access points or in the terminals of the wireless local area network, additional messages carried out or data captured. This means that the resources of the local mobile radio network do not have to be used to determine and set the optimal carrier frequency.

Preferably, the computer-based system is set up to capture present operational values of the first computerized access point via the communication connection. Without changes to the access points, standard operational values of the access points can thus be captured by the computer-based system via the communication connection, and stored in the computer-based system. Operational values, which are captured by the computer-based system from the computerized access points include, for instance, indications about the present number of users who are associated with the respective computerized access point, about the present number of received faulty data packets in the respective computerized access point and about the present number of received errorless data packets in the respective computerized access point.

According to the invention, the computer-based system is set up to calculate weighting factors for the computerized access points, each based on the captured operational values of the respective computerized access point, and to store access point data comprising the calculated weighting factor of the first computerized access point and weighting factors of the second computerized access points. According to the invention, the computer-based system is set up to determine the optimal carrier frequency for the first computerized access point based on the stored present carrier frequency of the first computerized access point, based on the stored weighting factors of the second computerized access points and based on the stored present carrier frequencies of the second computerized access points. By determining and storing weighting factors for the computerized access points based on

operational values of the access points and by taking into consideration the weighting factors in determining the optimal carrier frequencies, the degree of relevance and influence of a neighboring computerized access point for ascertaining the optimal carrier frequencies can be determined according to defined criteria.

In an embodiment variant, the computer-based system is set up to calculate the weighting factor for the first computerized access point based on a use rate of the first computerized access point, based on a failure rate of the first computerized access point and based on a use probability of the first computerized access point. The computer-based system calculates the weighting factor for an access point based, for example, on the use rate, which is calculated by division of the captured number of users of the first access point by a maximal number of users of the first access point, based on a failure rate, which is calculated by division of the captured number of received faulty data packets at the first access point by the total number of received data packets at the first access point, and based on a use probability, which, according to Poisson, for example, is calculated from stored historical values for the captured number of users of the first access point. The influence of a neighboring access point on the determination of the optimal carrier frequencies can thus be made to depend upon how frequently the respective neighboring access point is used by users with terminals, how much the respective neighboring access point is burdened with failures, and how great the probability is that the respective neighboring access point is used by users with terminals. The use rate is preferably weighted more heavily, e.g. three times as much, than the failure rate and the use probability.

According to the invention, the computer-based system is set up to determine the optimal carrier frequency for the first computerized access point in that from among a multiplicity of defined radio frequency channels one radio frequency channel with an assigned carrier frequency is selected such that the sum of the differences between the assigned carrier frequency and the stored

present carrier frequencies of the second computerized access points is as large as possible, the differences being weighted in each case by the stored weighting factor of the respective second computerized access point. This means that the optimal carrier frequency, or respectively an optimal radio frequency channel, is determined such that the frequency separation from the carrier frequencies, or respectively radio frequency channels, of neighboring access points is as large as possible, the frequency separation in particular to those neighboring access points having a higher weighting factor being as large as possible, for example because they have a high use rate or a high failure rate.

Preferably, the computer-based system is set up to carry out determination of the optimal carrier frequency for the first computerized access point when captured present operational values of the first computerized access point indicate that the present number of users who are associated with the first computerized access point is zero, and that the present number of received faulty data packets at the first computerized access point exceeds a defined tolerance value. Consequently the carrier frequencies are changed in an access point only when the access point is not being used by users with terminals. In this way signal losses for users during channel change are prevented without special messages having to be sent for this purpose to the terminals of users by the computerized access points, for which the resources of the local mobile radio network would have to be used.

AMENDED PAGE

Claims

1. Computer-based system (4, 4') for dynamic assignment of carrier frequencies to computerized access points (AP1, AP2, APn) of a wireless local area network (7), comprising:

a communication module for connection of the computer-based system (4, 4') via a communication connection (6) to the computerized access points (AP1, AP2, APn),

a memory module (105) for storing access point data about the computerized access points (AP1, AP2, APn), which access point data comprise in each case at least the present carrier frequency of the respective computerized access point (AP1, AP2, APn),

an optimization module (100) for determining a carrier frequency for a first of the computerized access points (AP2), based on the stored access point data about the computerized access points (AP1, AP2, APn), and

a channel switching module (101) for setting the determined carrier frequency in the first computerized access point (AP2) via the communication connection (6),

characterized in that

the computer-based system (4, 4') comprises means for calculating weighting factors for the computerized access points (AP1, AP2, APn), each based on captured operational values of the respective computerized access point (AP1, AP2, APn),

the memory module (105) is set up to store access point data comprising the calculated weighting factors of the computerized access points (AP1, AP2, APn), and

the optimization module (100) is set up to determine the carrier

frequency for the first computerized access point (AP2) in that from among a multiplicity of defined radio frequency channels one radio frequency channel with an assigned carrier frequency is selected such that the sum of the differences between the assigned carrier frequency and the stored present carrier frequencies of the second computerized access points (AP1, APn) is as large as possible, the differences being weighted in each case using the stored weighting factor for the respective second computerized access point (AP1, APn).

2. Computer-based system (4, 4') according to claim 1, characterized in that it comprises a monitoring module (101) for capturing the present operational values of the first computerized access point (AP2) via the communication connection (6)

3. Computer-based system (4, 4') according to claim 1 or 2, characterized in that the means for calculating weighting factors are set up to calculate the weighting factor for the first computerized access point (AP2) based on a use rate for the first computerized access point (AP2), based on a failure rate for the first computerized access point (AP2) and based on a use probability for the first computerized access point (AP2).

4. Computer-based system (4, 4') according to one of the claims 2 or 3, characterized in that the monitoring module (103) is set up to capture a present operational value of the first computerized access point (AP2) indicating the present number of users who are associated with the first computerized access point (AP2), to capture a present operational value of the first computerized access point (AP2) indicating the present number of received faulty data packets at the first computerized access point (AP2), and to capture a present operational value of the first computerized access point (AP2) indicating the present number of received errorless data packets at the first computerized access point (AP2).

5. Computer-based system (4, 4') according to claim 4, characterized

in that the means for calculating weighting factors are set up to calculate the weighting factor for the first computerized access point (AP2), based on a use rate which is calculated by dividing the captured number of users of the first computerized access point (AP2) by a maximal number of users of the first computerized access point (AP2), based on a failure rate, which is calculated by dividing the captured number of received faulty data packets at the first computerized access point (AP2) by the total number of received data packets at the first computerized access point (AP2), and based on a use probability which is calculated from stored historical values for the captured number of users of the first computerized access point (AP2).

6. Computer-based system (4, 4') according to one of the claims 1 to 5, characterized in that it is set up to activate the optimization module (100) for determining the carrier frequency of the first computerized access point (AP2) when captured present operational values of the first computerized access point (AP2) indicate that the present number of users who are associated with the first computerized access point (AP2) is zero, and that the present number of received faulty data packets at the first computerized access point (AP2) exceeds a defined tolerance value.

7. Computer-based system (4, 4') according to one of the claims 2 to 6, characterized in that it comprises a first autonomous agent module (AM2), which is assigned to the first computerized access point (AP2), in that it comprises second autonomous agent modules (AM1, AMn) which are each assigned to one of the second computerized access points (AP1, APn), in that the first and the second agent modules (AM1, AM2, AMn) are each implemented functionally in the same way, and comprise a monitoring module (103), a memory module (105), means for calculating weighting factors, an optimization module (100), a channel switching module (101) as well as an update module (104), which update module (104) is set up to exchange the access point data about the assigned computerized access point (AP1, AP2, APn) among the agent modules (AM1, AM2, AMn), the access point data

comprising in each case an access point identification, the present carrier frequency and the calculated weighting factor of the assigned computerized access point (AP1, AP2, APn), in that the agent modules (AM1, AM2, AMn) are each set up to activate the monitoring module (103) of the respective agent module (AM1, AM2, AMn) periodically to capture present operational values in the associated computerized access point (AP1, AP2, APn), and in that the agent modules (AM1, AM2, AMn) are each set up to activate the update module (104) of the respective agent module (AM1, AM2, AMn) for the exchange of the access point data after a determined carrier frequency has been set by the channel switching module (101) of the respective agent module (AM1, AM2, AMn) in the associated computerized access point (AP1, AP2, APn).

8. Computer-based system (4, 4') according to claim 7, characterized in that the memory module (105) is set up to store historical access point data about the computerized access points (AP1, AP2, APn), and in that the agent modules (AM1, AM2, AMn) are each set up not to activate the update module (104) of the respective agent module (AM1, AM2, AMn) for the exchange of the access point data if the stored access point data of the respective agent module (AM1, AM2, AMn) coincide with historical access point data of the respective agent module (AM1, AM2, AMn).

9. Computer-based system (4, 4') according to one of the claims 7 or 8, characterized in that the first autonomous agent module (AM2) and the second autonomous agent modules (AM1, AMn) are each implemented on a separate computer (1, 2, 3), the separate computers (1, 2, 3) being connected to one another via a communication connection (5).

10. Computer-based system (4, 4') according to one of the claims 7 or 8, characterized in that the first autonomous agent module (AM2) and/or at least some of the second autonomous agent modules (AM1, AMn) are implemented on a common computer.

11. Computer program product comprising: a computer-readable

medium with computer program code means contained therein for control of one or more processors of a computer-based system (4, 4') for dynamic assignment of carrier frequencies to computerized access points (AP1, AP2, APn) of a wireless local area network (7) that are connectible to the computer-based system (4, 4') via a communication connection (6) such that

access point data about the computerized access points (AP1, AP2, APn) are stored in the computer-based system (4, 4'), which access point data each comprise at least the present carrier frequency of the respective computerized access point (AP1, AP2, APn),

a carrier frequency for a first of the computerized access points (AP2) is determined by the computer-based system (4, 4'), based on the stored access point data about the computerized access points (AP1, AP2, APn), and

the determined carrier frequency is set in the first computerized access point (AP2) by the computer-based system (4, 4') via the communication connection (6),

characterized in that

the computer program product comprises further computer program code means which control the processors of the computer-based system (4, 4') such that

a weighting factor is calculated by the computer-based system (4, 4') for the computerized access points (AP1, AP2, APn) based in each case on captured operational values of the respective computerized access point (AP1, AP2, APn),

access point data are stored in the computer-based system (4, 4') which comprise the calculated weighting factors of the computerized access points (AP1, AP2, APn), and

the carrier frequency for the first computerized access point (AP2) is determined by the computer-based system (4, 4') in that from among a

multiplicity of defined radio frequency channels one radio frequency channel with an assigned carrier frequency is selected such that the sum of the differences between the assigned carrier frequency and the stored present carrier frequencies of the second computerized access points (AP1, APn) is as large as possible, the differences being weighted in each case using the stored weighting factor for the respective second computerized access point (AP1, APn).

12. Computer program product according to claim 11, characterized in that it comprises further computer program code means, which control the processors of the computer-based system (4, 4') such that present operational values of the first computerized access point (AP2) are captured by the computer-based system (4, 4') via the communication connection (6).

13. Computer program product according to one of the claims 11 or 12, characterized in that it comprises further computer program code means which control the processors of the computer-based system (4, 4') such that the weighting factor for the first computerized access point (AP2) is calculated by the computer-based system (4, 4') based on a use rate for the first computerized access point (AP2), based on a failure rate for the first computerized access point (AP2) and based on a use probability for the first computerized access point (AP2).

14. Computer program product according to one of the claims 11 to 13, characterized in that it comprises further computer program code means, which control the processors of the computer-based system (4, 4') such that a present operational value for the first computerized access point (AP2) is captured by the computer-based system (4, 4') indicating the present number of users who are associated with the first computerized access point (AP2), in that a present operational value for the first computerized access point (AP2) is captured by the computer-based system (4, 4') indicating the present number of faulty data packets received at the first computerized access point (AP2), and in that a present operational value for first computerized access point (AP2) is captured by the computer-based system (4, 4') indicating the present number

of errorless data packets received at the first computerized access point (AP2).

15. Computer program product according to claim 14, characterized in that it comprises further computer program code means that control the processors of the computer-based system (4, 4') such that the weighting factor for the first computerized access point (AP2) is calculated based on a use rate, which is calculated by division of the captured number of users of the first computerized access point (AP2) by a maximal number of users of the first computerized access point (AP2), based on a failure rate which is calculated by division of the captured number of received faulty data packets at the first computerized access point (AP2) by the total number of received data packets at the first computerized access point (AP2), and based on a use probability which is calculated from stored historical values for the captured number of users of the first computerized access point (AP2).

16. Computer program product according to one of the claims 11 to 15, characterized in that it comprises further computer program code means that control the processors of the computer-based system (4, 4') such that the computer-based system (4, 4') carries out the determination of the carrier frequency of the first computerized access point (AP2) if captured present operational values of the first computerized access point (AP2) indicate that the present number of users who are associated with the first computerized access point (AP2) is zero, and that the present number of received faulty data packets at the first computerized access point (AP2) exceeds a defined tolerance value.

17. Computer program product according to one of the claims 11 to 16, characterized in that it comprises further computer program code means that control the processors of the computer-based system (4, 4') such that the computer-based system (4, 4') acts as a first autonomous agent module (AM2), which is assigned to the first computerized access point (AP2), in that the computer-based system (4, 4') acts as second autonomous agent modules (AM1, AMn) which are each assigned to one of the second computerized access points (AP1, APn), in that the computer-based system (4, 4')

periodically captures present operational values of the computerized access points (AP1, AP2, APn), to which agent modules (AM1, AM2, AMn) are assigned, in that access point data about the computerized access points (AP1, AP2, APn) are exchanged by the computer-based system (4, 4') among the agent modules (AM1, AM2, AMn) after the determined carrier frequency has been set in a computerized access point (AP1, AP2, APn), to which an agent module (AM1, AM2, AMn) is assigned, by the computer-based system (4, 4'), the access point data each comprising an access point identification, the present carrier frequency and the calculated weighting factor of the respective computerized access point (AP1, AP2, APn).

18. Computer program product according to claim 17, characterized in that it comprises further computer program code means that control the processors of the computer-based system (4, 4') such that in the computer-based system (4, 4') historical access point data about the computerized access points (AP1, AP2, APn) are stored, and in that access point data about the computerized access points (AP1, AP2, APn) are not exchanged by the computer-based system (4, 4') among the agent modules (AM1, AM2, AMn) if the stored access point data of the agent module (AM1, AM2, AMn) which is assigned to the access point (AP1, AP2, APn), in which a determined carrier frequency was set, coincide with historical access point data.

1/2

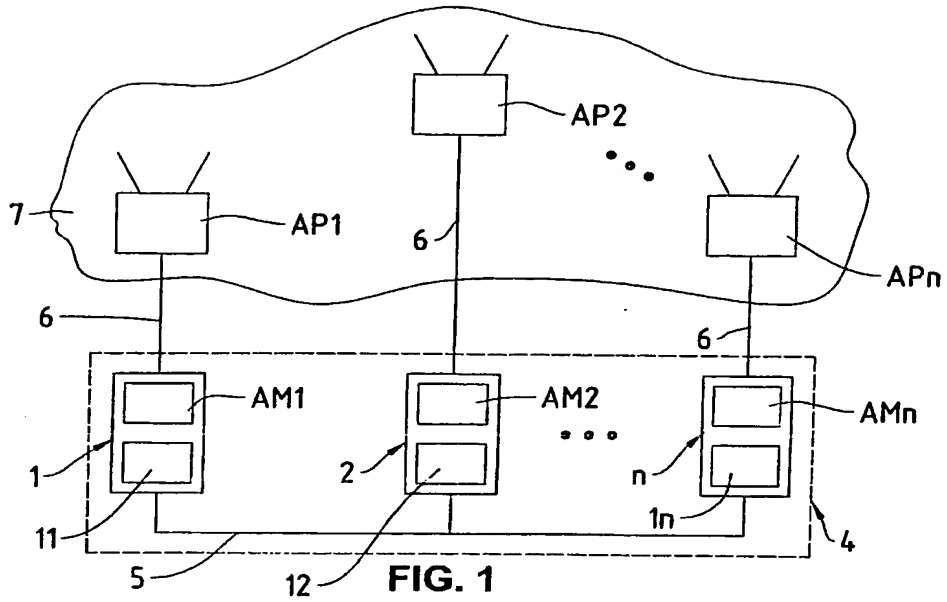
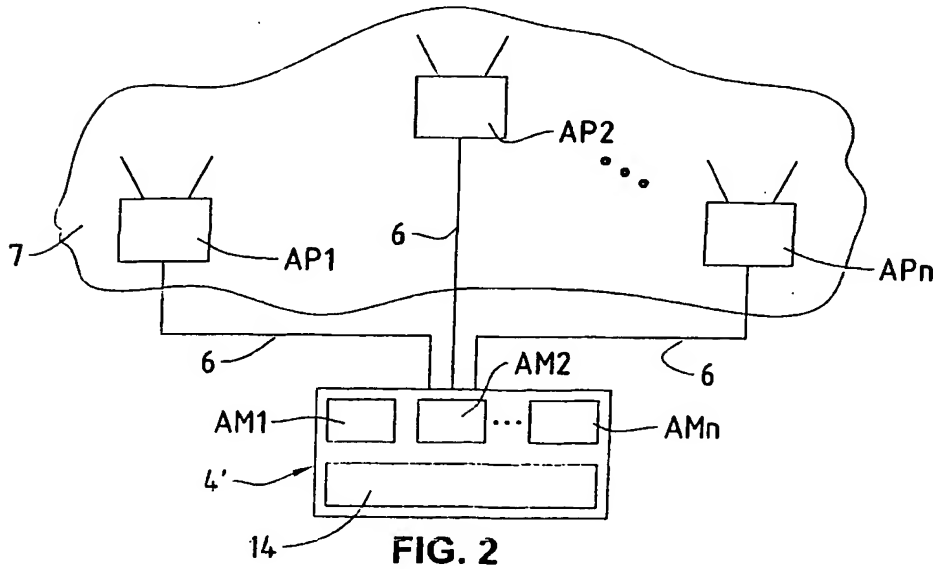

AP2
7
AP1
6
APn
6
6
AM1
AM2
AMn
1
2
n
1n
11
5
12
4

FIG. 1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AP1
6
APn
6
6
AM2
AM1
AMn
4'
14

FIG. 2

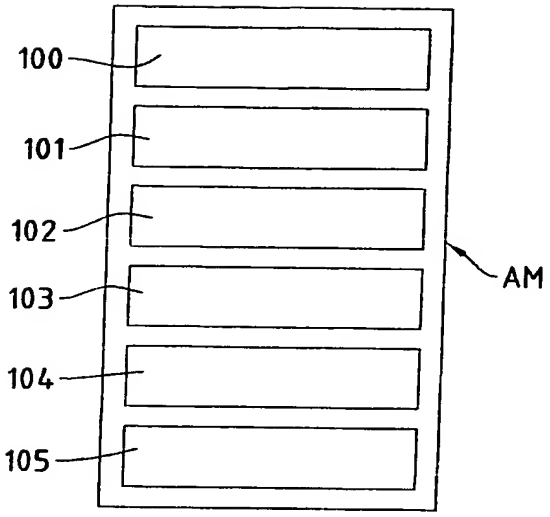

FIG. 3

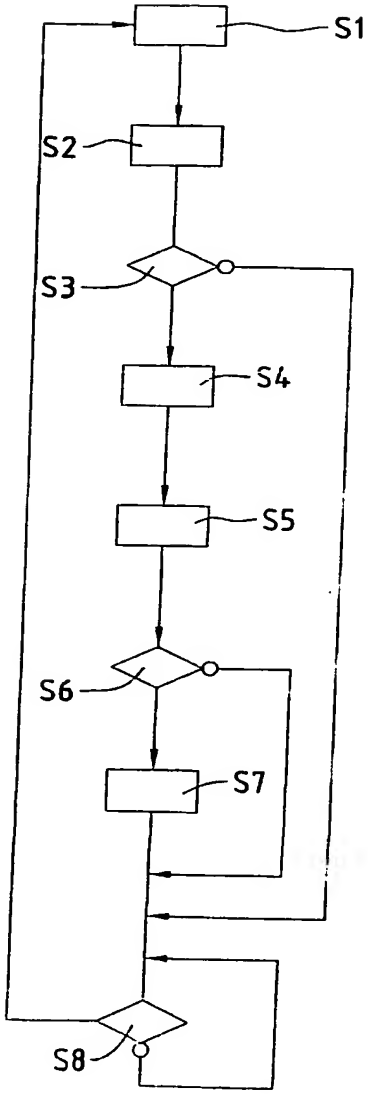

FIG. 4